Extraction

Definition of Extraction:

- Extraction may be defined as the removal of soluble constituents from a solid or liquid or semi-solid with means of suitable solvent.
- It may be defined as the treatment of the plant or animal tissues with appropriate solvent, which would dissolve the medicinally active constituents.
- Extraction is the method of removal of a soluble fraction in the form of a solution from an insoluble matrix with the help of a suitable solvent.
- The soluble components may be present either as
    - a solid or liquid
- Insoluble matrix may be
    - in powder form, openly porous or nonporous or cellular with selective permeable cell walls as in case of vegetable and animal tissues

Types of extraction: In most applications in the food industry, however, this term will refer to two rather distinct processes:

1. **Liquid-solid leaching**

Leaching refers to the removal of some soluble component from a solid by using a liquid solvent. This process can be accomplished in a variety of ways but, as might be expected, its efficiency depends to a great extent on attaining intimate contact between the liquid solvent and the solid containing the solute. The leaching of sucrose from sugar beets utilizing hot water as a solvent and the removal of edible oils from soy beans are just two examples of leaching related to food processing.

2. **Liquid-liquid extraction**

Liquid-liquid extraction involves the removal of a solute from one liquid phase and provides for removal or pick-up of this solute by a second liquid phase. The two liquid phases are partially immiscible so that the efficiency of the separation process again depends on maintaining intimate contact between the two liquid phases. Probably the best example of liquid extraction related to food processing is in the purification of animal fat. In this particular application, the fat is one liquid phase and a solvent is utilized to remove undesirable component from it.

Rate of Extraction: The rate at which extraction proceeds is a measure of the rate at which the solute is transferred from one phase to another.

This rate, for either leaching or liquid-liquid extraction, will depend on several factors including:

a. **Particle size:** Particle size will influence the rate of leaching in two ways: smaller particles have larger interfacial area between the solid and liquid and a short distance for the solute to diffuse within the particle to reach the particle surface.
b. **The solvent:** The selection of a solvent is a significant factor in both leaching and liquid-liquid extraction. In general, a solvent should be chosen that is selective for the solute being removed, and the solvent should have low viscosity to promote circulation in both processes.
c. **Temperature:** Temperature is a factor because of the increased solubility resulting from increased temperature.
d. **The agitation of the fluid:** Stronger agitation results in increased diffusion and a reduced resistance to mass transfer at the particle surface during the leaching process. For liquid-liquid extraction, an increase in agitation promotes more intimate contact between the two liquids involved in the process.

Methods of Extraction: The principle methods of extraction are -

• Maceration
• Percolation
• Digestion
• Infusion
• Decoction

Soxhlet Extraction:

This is a continuous process of extraction with a hot solvent. Soxhlet extractors are used for this purpose. This extractor is provided with a siphoning system. The powdered plant material is packed in a thimble. The solvent is boiled in a flask. The evaporated solvent passes through the side tube of the extractor and condensed in the condenser, fitted at the top of the extractor. The condensed hot solvent runs into the thimble and soaks the material & extracts the constituents. When the chamber holding the thimble becomes full the solvent siphons down to the flask and the process is continuously repeated till extraction is complete.

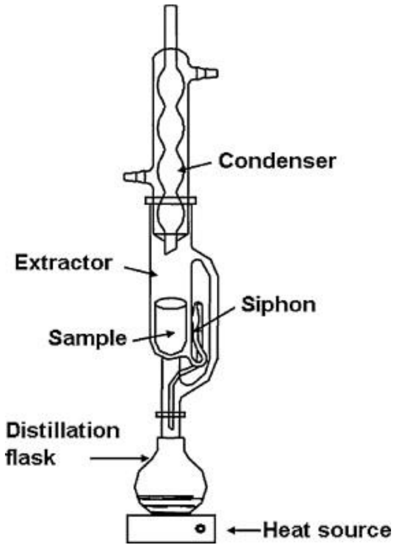

Fig: Soxhlet apparatus

Supercritical Fluid Extraction:

Supercritical fluids have been investigated since last century, with the strongest commercial interest initially focusing on the use of supercritical toluene in petroleum and shale oil refining during the 1970s. Supercritical water is also being investigated as a means of destroying toxic wastes, and as an unusual synthesis medium. The biggest interest for the last decade has been the applications of supercritical carbon dioxide, because it has a near ambient critical temperature (31^0C), thus biological materials can be processed at temperatures around 35^0C. The density of the supercritical CO_2 at around 200 bar pressure is close to that of hexane, and the solvation characteristics are also similar to hexane; thus, it acts as a non-polar solvent. Around the supercritical region, CO_2 can dissolve triglycerides at concentrations up to 1% mass. The major advantage is that a small reduction in temperature, or a slightly larger reduction in pressure, will result in almost the entire solute precipitating out as the supercritical conditions are changed or made sub critical. Supercritical fluids can produce a product with no solvent residues. Examples of pilot and production scale products include decaffeinated coffee, cholesterol-free butter, low-fat meat, evening primrose oil, squalene from shark liver oil, etc. The solvation characteristics of supercritical CO2 can be modified by the addition of an entrainer, such as ethanol, however some entrainer remains as a solvent residue in the product, negating some of the advantages of the "residue-free" extraction.

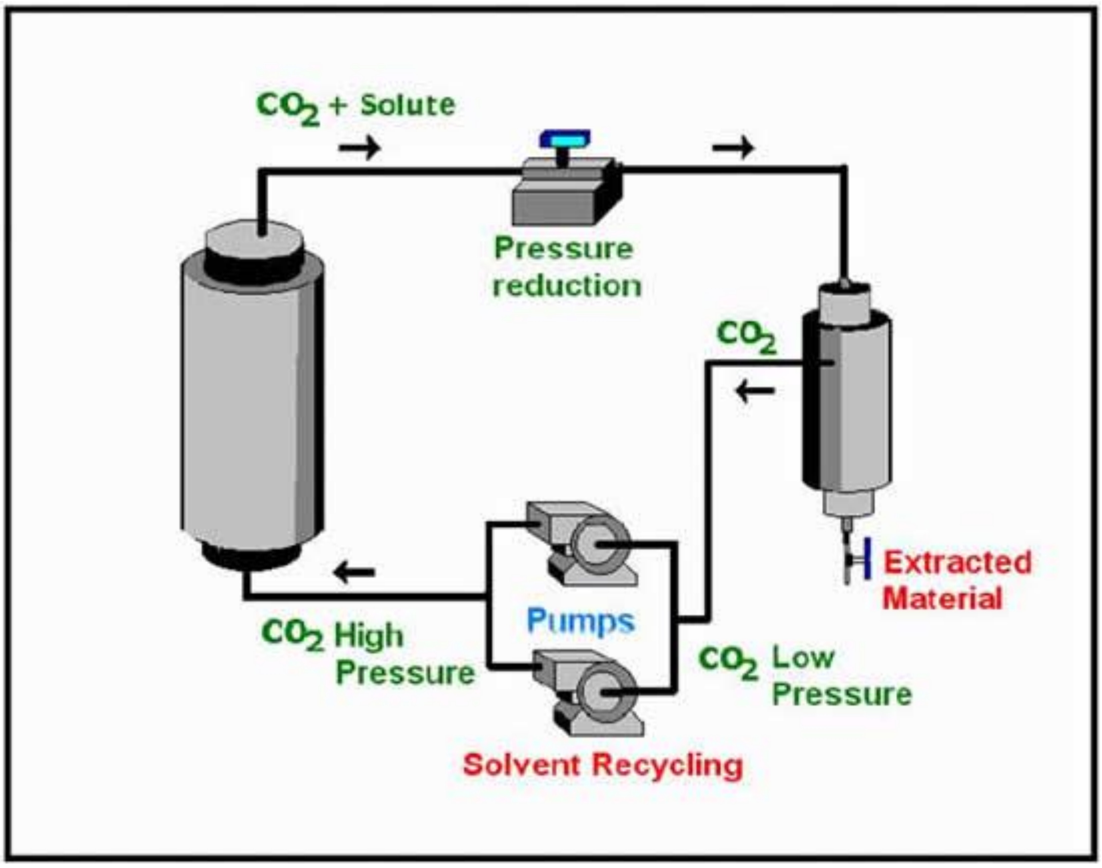

Fig: A schematic diagram of a supercritical fluid continuous extraction.